The Integration of Science and Management in a Monitoring Program

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Greater Yellowstone Inventory and Monitoring Network

GRYN

The Integration of Science and Management in a Monitoring Program

"Unfortunately, little evidence supports the idea that such programs <*large-scale monitoring programs*> have contributed to informed management decisions or proven valuable in averting biological crises (GAO 1988, NRC 1990)."

Noon 2003

The Barriers of Science and Management

How do we ensure that the Science from a Monitoring Program is useful to Management?

The goal should be providing the right information to the right people in the right form at the right time.

So, how do we do this?

The Right Information

Information needs to be applicable and it needs to be reliable.

Is the problem well suited for a science solution?

Adapted from Lee (1993) and Thomson and Tuden (1959)

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Is the problem well suited for a science solution?

If the conflict is better suited to a policy solution, then science often serves as a displacement behavior.

Adapted from Lee (1993) and Thomson and Tuden (1959)

Is the problem well suited for a science solution?

OK, not all problems are well suited to a science solution… so what?

Is the problem well suited for a science (monitoring) solution?

- Information, rather than politics is limiting decisions
- Management repeated over time/space
- Uncertainty re ecological outcome
- Reasonable management control/options
- Reasonable institutional cooperation

Identifying Information Needs

Quite often, information needs are determined based on:

- Tradition
- What is in the literature
- What is easiest to get

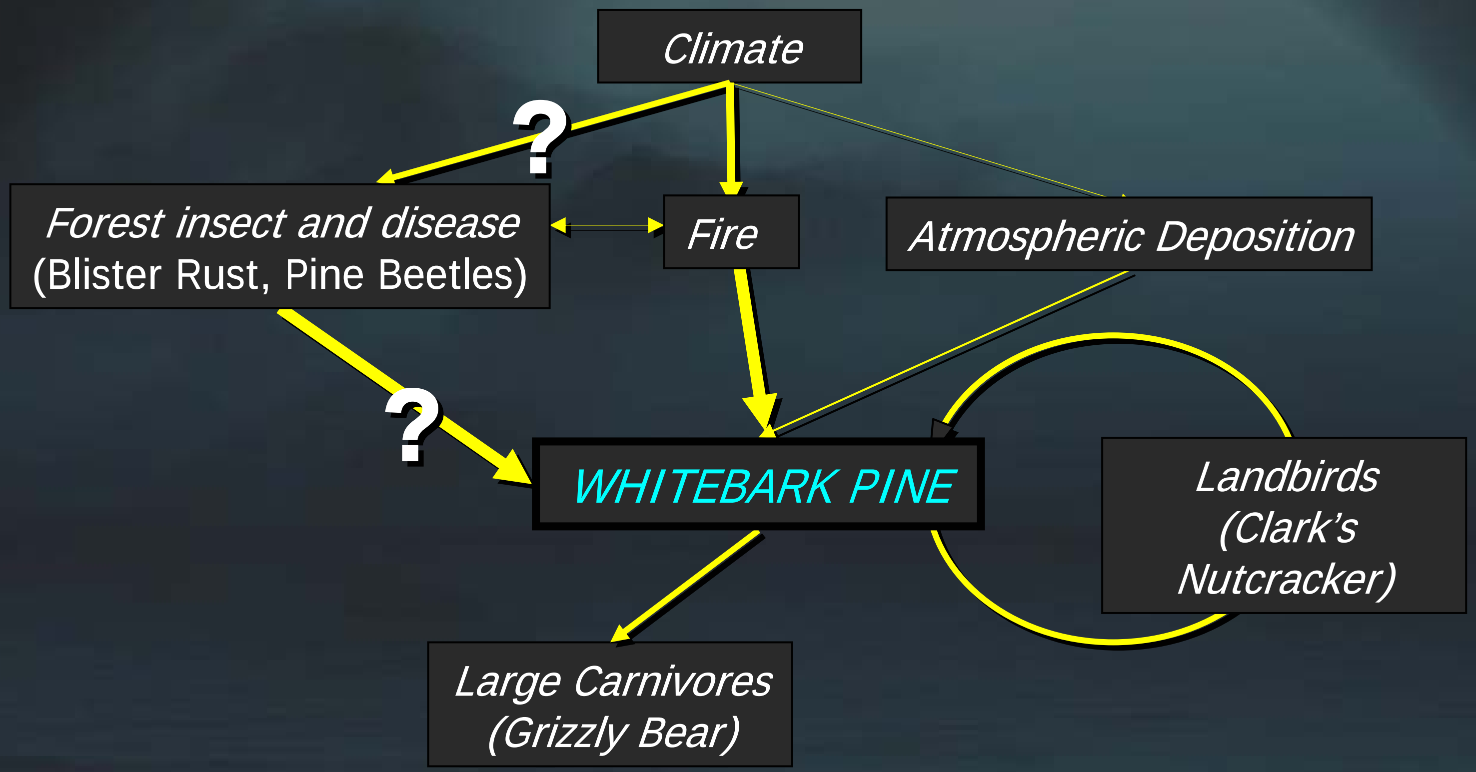
We need to ask ourselves what would we do with the information if we had it?

Identifying Information Needs

Model building

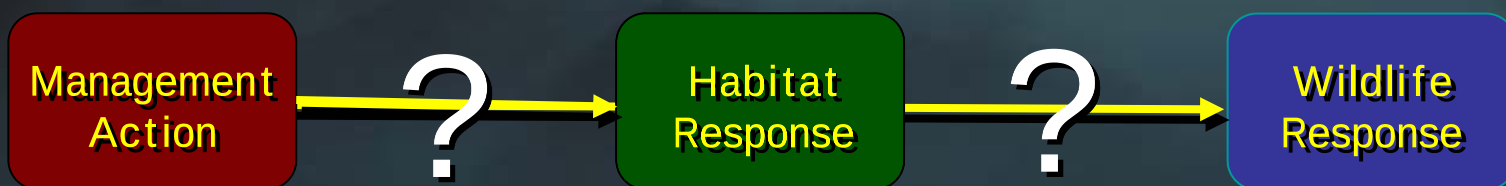
- Models help us to recognize what we don’t know.
- Start with simple conceptual models
- Highlight key uncertainties

Identifying Information Needs



Identifying Information Needs

Understand the difference and relationship between objectives and goals at different spatial, temporal, and organizational scales.



Generally speaking (no pun intended), the more specific you can be, the greater the opportunity to learn

Objectives

Specific and Measurable

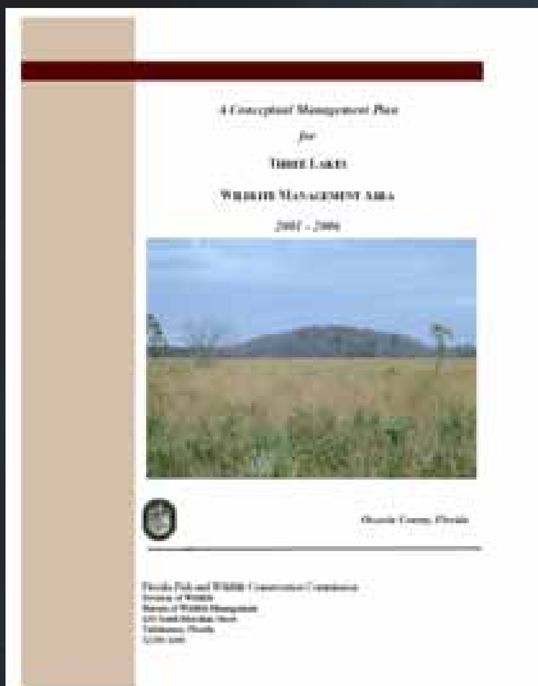
Non-specific- *To improve wildlife habitat.*

Specific- *To increase grass production by 30%, with an expectation that this will result in a 15% increase in the number of pronghorn.*

Note: You do not need to be correct in your initial predictions.

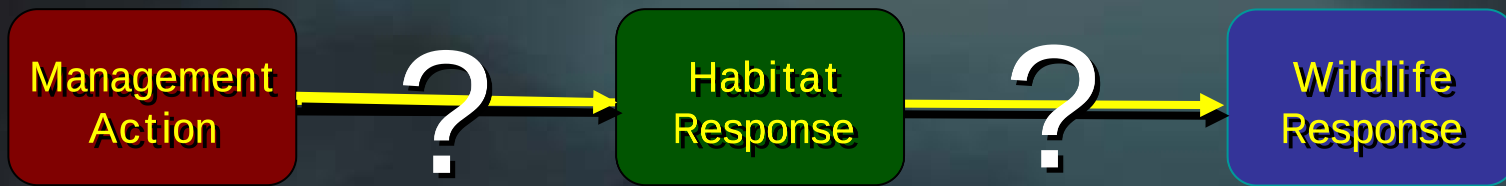
Objectives

Action vs State (end vs means)



		Objectives	Percent and Date Accomplished
Objective 2:		Use fire to maintain and encourage plant communities, especially the dry prairie and longleaf and slash pine flatwoods.	100% - ongoing
	a.	Both fall/winter fires and spring/summer fires will be utilized in the flatwoods and prairie types. These burns will mostly be restricted to relatively small blocks. Stress to overstory species will be avoided.	100% - ongoing
	b.	These fires will be ignited with the intent of creating a mosaic or natural patchwork of burned and unburned areas.	100% - ongoing
	c.	Natural or existing firebreaks will be used whenever possible. New fire lines will be developed only when safety considerations dictate. Fire lines will be disked to avoid interference with natural drainage patterns.	100% - ongoing

Identifying Information Needs



"Action" objectives tend to focus on whether or not the management action was performed... rather than on the response to that management action

Example Action Objective: Periodically use fire in shrubland areas to improve wildlife habitat.

Objectives

Action vs State (end vs means)

Objectives

IF we really want to address management uncertainties through science, then we need to identify measurable conditions or states of the system (i.e. response variables), in addition to the activities intended to influence that condition or state.

i.e., the Desired Condition

Objectives

The Right Information
(Applicability)

Dry Prairie

Objectives

Action vs State (end vs means)

"Use fire to maintain and encourage plant communities, especially the dry prairie and longleaf and slash pine flatwoods."

Treatment	Air Temperature	Relative Humidity	Light Fuel Moisture	Resulting Shrub Cover
1	**17º C**	**15%**	**50%**	**52%**
2	**17º C**	**15%**	**10%**	**3%**
3	**17º C**	**15%**	**30%**	**24%**

Objectives

Action vs State (end vs means)

“Use fire to maintain and encourage plant communities, especially the dry prairie and longleaf and slash pine flatwoods.”

Using prescription fire, reduce the saw palmetto cover on 900 hectares of dry prairie habitat from its current state of 56% cover to a desired state of 25% cover.

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Management vs Monitoring Objectives

Management objectives should reflect the targeted (desired) condition, state, or dynamics of the system we are managing.

Monitoring objectives should reflect the desired measurement of the condition, state, or dynamics of the system.

note: Management objectives, expressed as a targeted state usually are an expression the desired condition.

Objectives

Active Management in National Parks

- People
- Fire
- Invasive Plants

UnDesired Condition

Desired Condition

We need to ask ourselves what would we do with the information if we had it?

Thresholds

Ecological Thresholds

Changing Ecosystem States

Thresholds

Thresholds of Potential Concern

after Biggs and Rogers 2003

Management Thresholds

Thresholds of Potential Concern

Ecological Risk

1% Decline in Deerfly Popn → Climate Change

Emotional, Political, etc Impact

Loss of a soil microbe → Extinction of Grizzly Bears

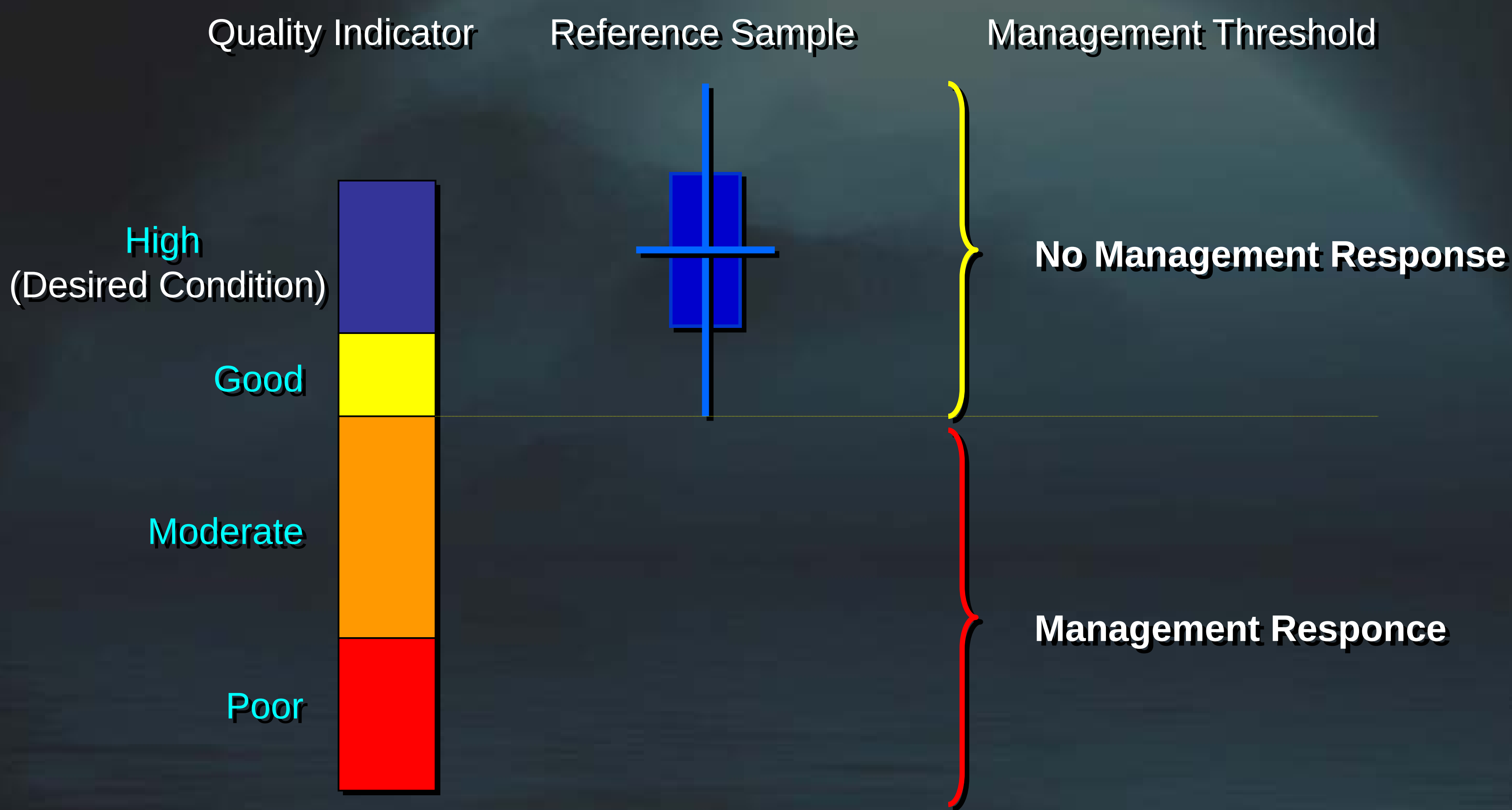
Potential for Management Control

Climate Change → Recreational Fishing

Low → High

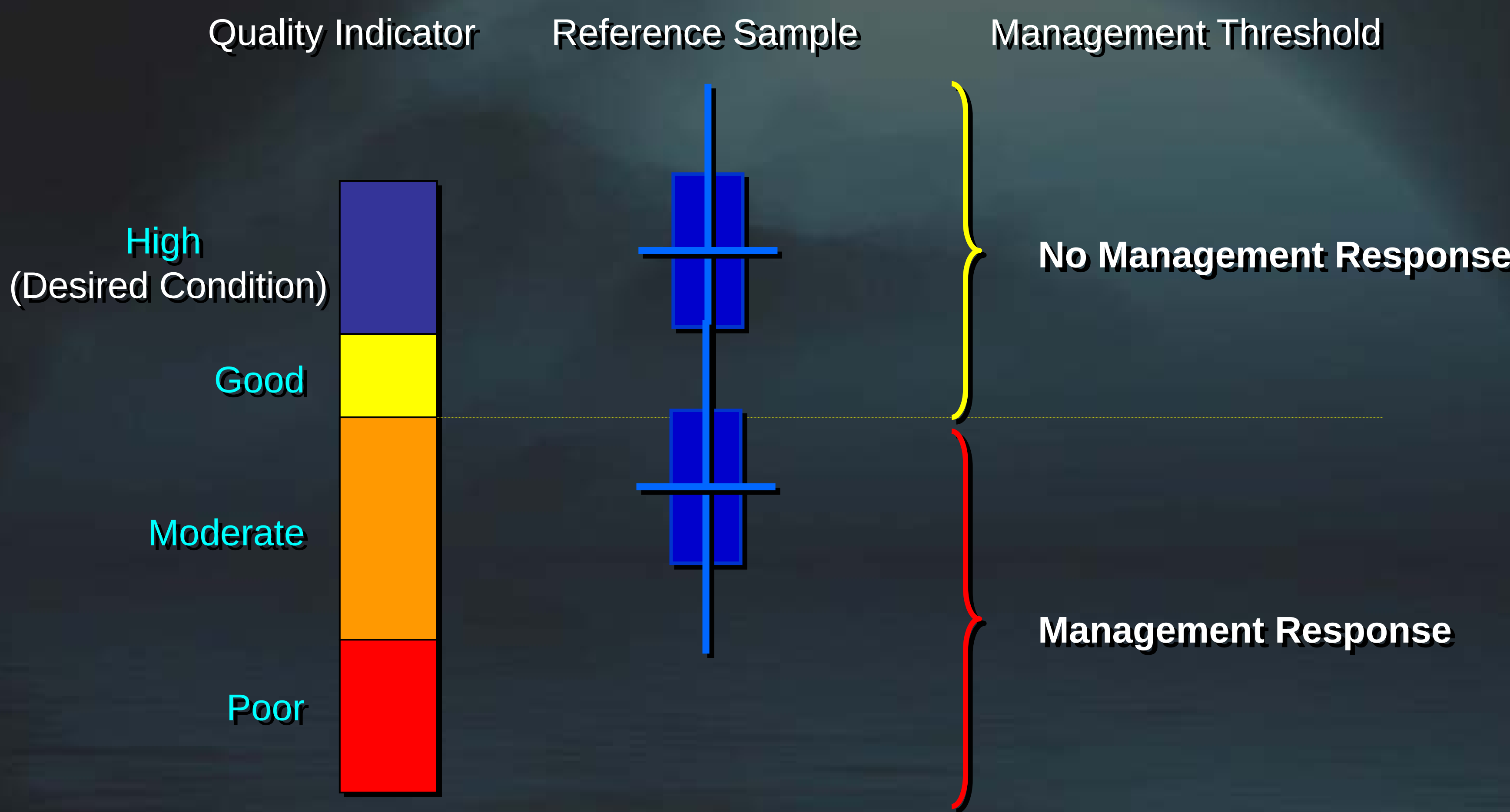
The Right Information
(Applicability)

Thresholds of Potential Concern



Adapted from Johnson 2001

Management Thresholds



Adapted from Johnson 2001

Thresholds

The Management Response need not be direct management action

Heightened awareness / reporting (e.g., alert manager of potential concern)

Change in monitoring (e.g., change in frequency/intensity)

Note: We need to consider and maintain management flexibility.

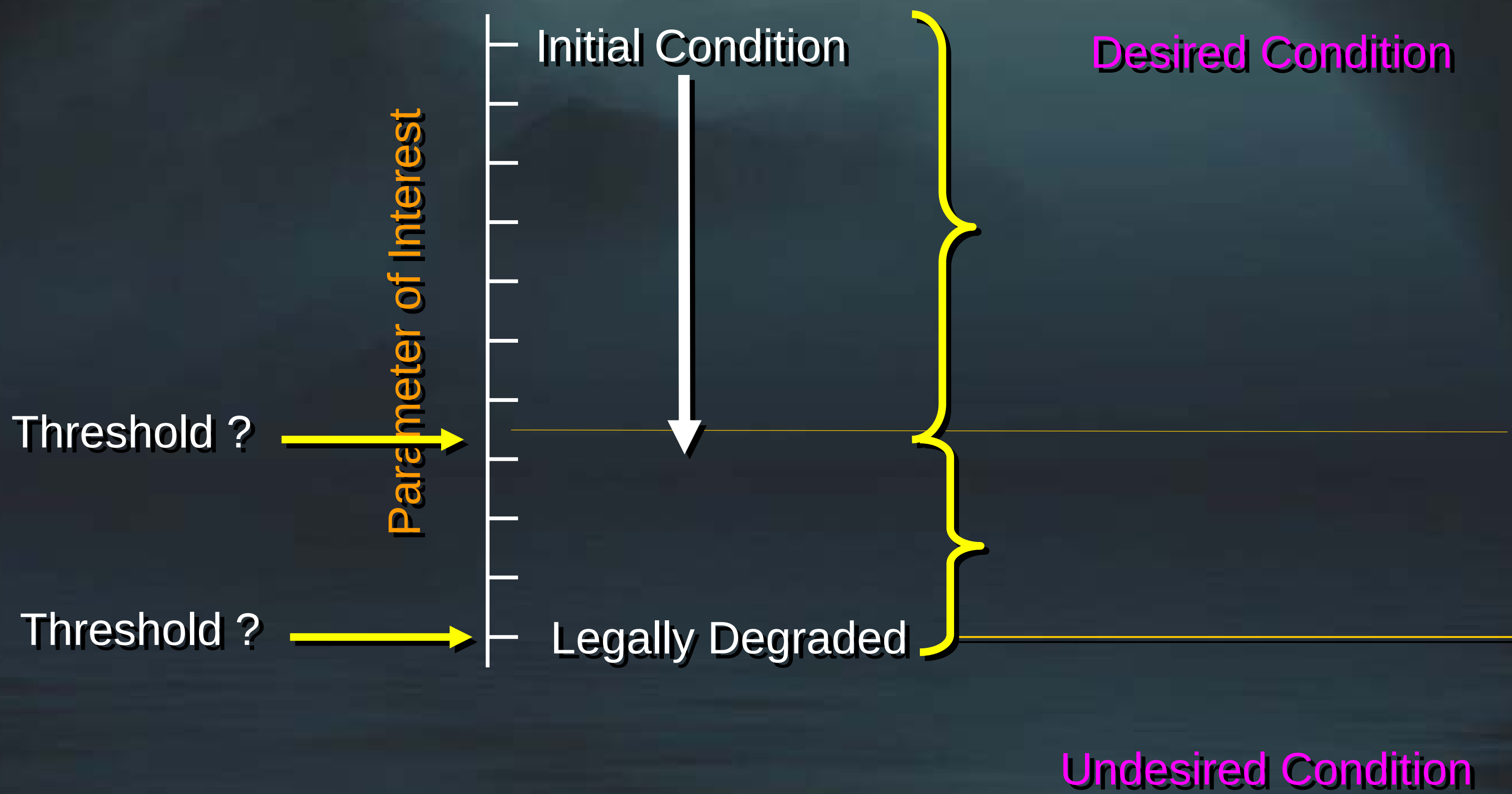
All “potential mgt responses need to be discussed and negotiated and need not come from the I & M program.

Recommended Mgt responses need not be public

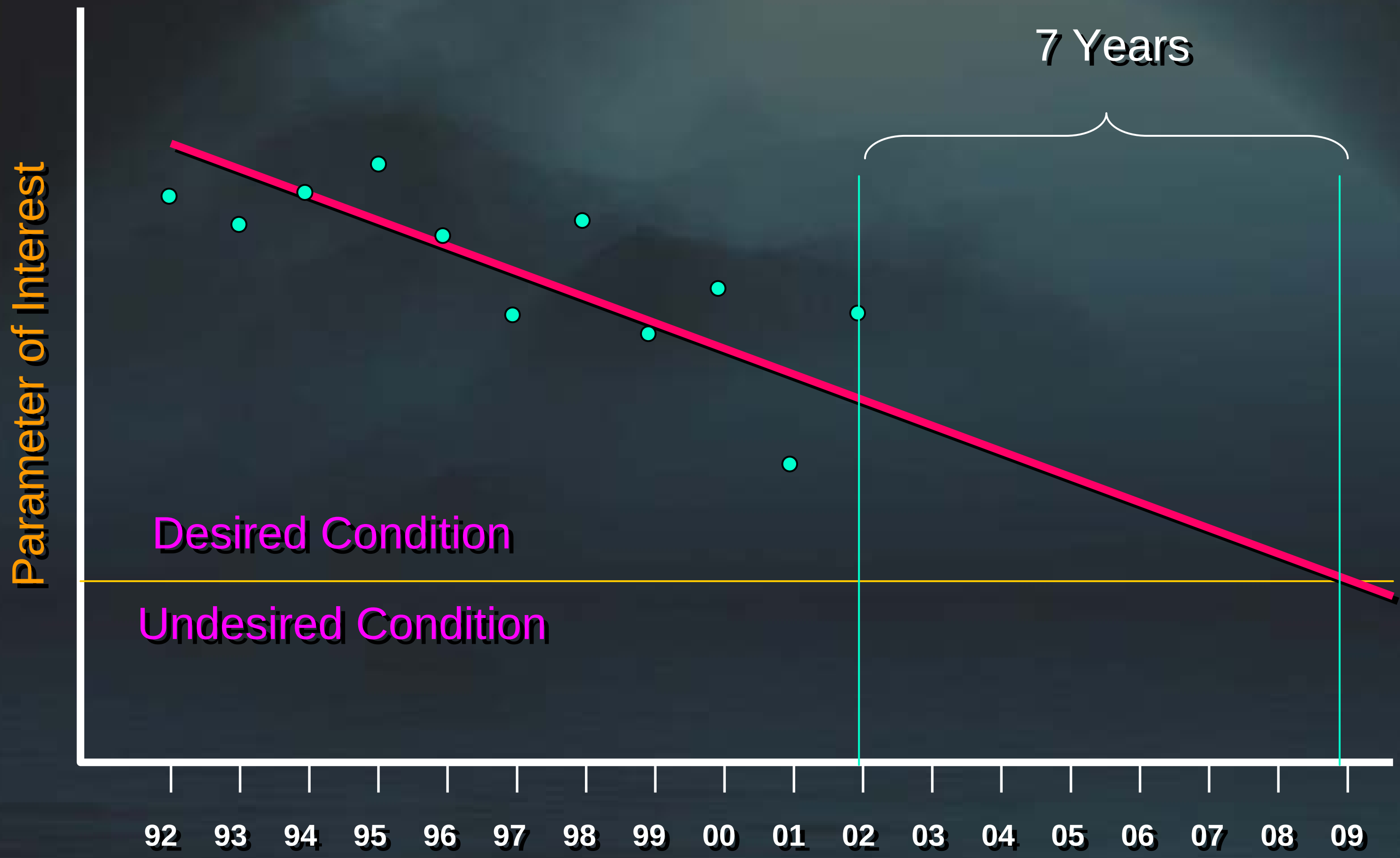
Mgt Response MUST be useful to Managers

Thresholds of Potential Concern

Outstanding National Resource Waters Maintained in "Unimpaired" Condition



Thresholds of Potential Concern



Adaptive Manageme

...tive management embodies a simple imperative:

...ent policies are experiments; ...learn from them!

Lee 1993

Terminology & Buzzwords

Adaptive Management

The Spirit of Adaptive Management

Think about the context of management options in the science planning.

Consider management options/actions as "treatments" in an experimental context.

Adaptive Management

1. Iterative Process
2. Two Primary Functional Components

Science / Learning

Monitoring

Assessment

Policy / Adaptive

Decisions

Adaptive Management

Re integrating science and management:

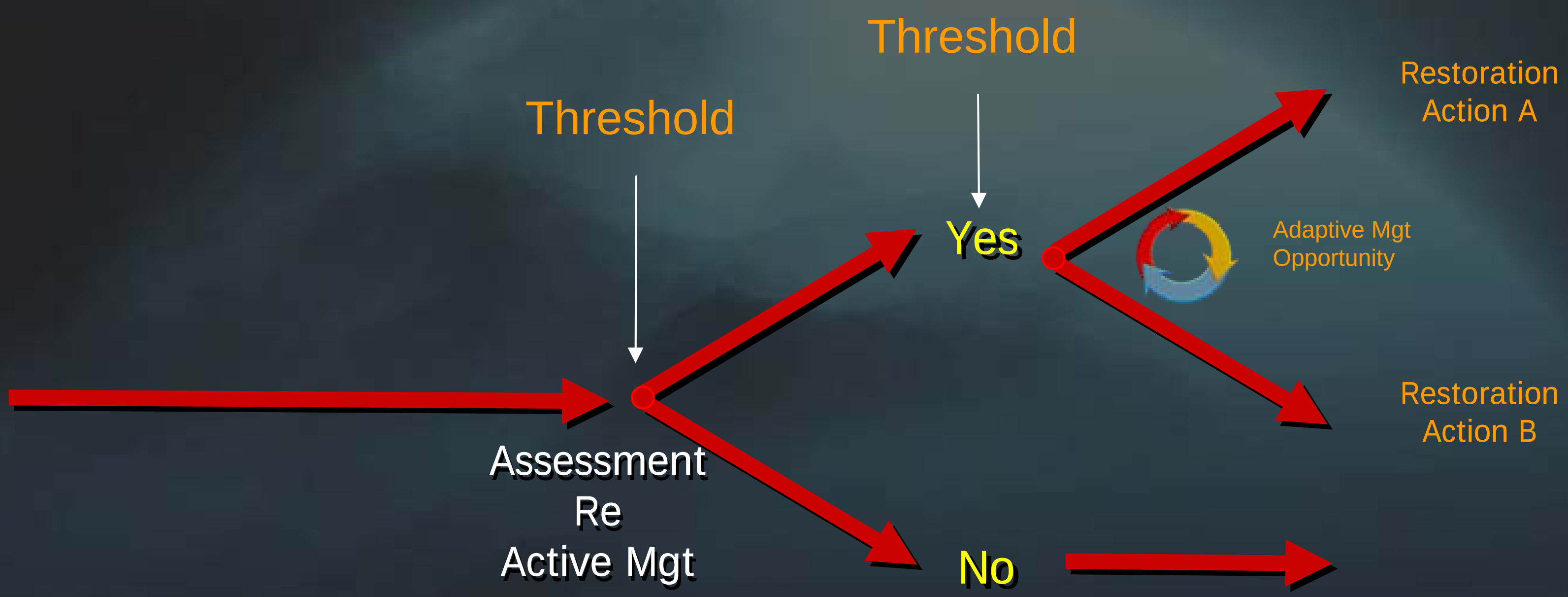
Management- Management still focuses on the management objectives, but learning becomes an additional objective.

Science- It is the management objectives that are the target (i.e., source of questions) for learning, with an explicit purpose of using what is learned to improve future management decisions.

So,,, in essence, management takes on a part of science (i.e., learning), and research takes on a part of management (i.e., the objectives).

The Right Information
(Applicability)

Adaptive Management



Adaptive Management

Barriers to Adaptive Management

Source: Jacobson et al. in press.

Logistical Barriers
- perceived lack of resources
- lack of clear timelines, goals and objectives

Communication Barriers
- inability to interact across disciplines
- lack of information flow within the management institution

Attitudinal Barriers
- misperceptions that managers and scientists have of each other
- concerns about job performance/accountability

Institutional Barriers
- procedures of an organization
- organizational structure and leadership styles

Conceptual Barriers
- lack of understanding or experience with the process of science/mgt

Educational Barriers
- Insufficient knowledge to design or implement program

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Adaptive Management Barriers

Table 1. Barriers to adaptive management based on a literature review.

Logistical	a
Need clear timeline, goals & objectives	6,9,17,25,26, 29,42
Political boundaries do not fit with ecosystem boundaries; trans-boundary issues	6,8,11,28,33,43
Lack of money/resources/staff	1,30,39,44
Monitoring plans insufficient	41,42,43
Conflicts of resources/priorities across management units	13,37
Lack of money for doing research experiments	38,41
Lack of time/resources for planning, implementing, monitoring	6,30
Need for regular meetings	32,40
Substantial, multilevel data requirements	26,31,42
Need forum for public support/involvement	8,26
Communication	
Lack of a belief in teamwork	3,9,10,12,13,15,20,31,34,37,38,44
Lack of interaction/negotiation among scientists/mgrs/decision makers/stakeholders	6,11,13,20,26,29,42
Need for external collaborative partnerships; Peer review	11,17,25,27,29,31
Need for public/stakeholder support	8,11,17,34,44
Stakeholders need to feel safe questioning ideas	10,12,29,44
Interdisciplinary communication problems of jargon, paradigms	9,14,35,37
Need for scientists to communicate results effectively	6,14,
Past unsuccessful experiences working with others	19,35
Need for interaction in the field	9
Attitudinal	
Data collection & monitoring is valued	1,9,10,12,40,41
Stakeholders need to feel input affects outcome	9,10,12,20,29,40
Objectives reflect stakeholders' values	20,21,33,39
Managers used to risk-averse policies	9,28,39
Fear of admitting uncertainty/distrust of the process	27,31,41
Risk to sensitive species/ESA	19,37,39
Scientists must view managers as equal partners/value applied management needs	9,39
Belief workload/accountability will be increased	19
Belief flexibility will be decreased	19
Institutional	
Culture of agency impedes success	2,4,15,16,20,21,31,41,42,43
Need for adaptive learning environment	7,10,16,17,26,31,41,42,43
Need for flexible framework	20,31,39,41,43
Lack of framework for decision making; top down approach	13,28,31
De-emphasis on individual thinking	7,31,39
Training needs to be team-based	22,27
Unsuccessful experience with past management mandates	19
Lack of long-term time frame	19
Conceptual	
Need for systems view of process	1,3,5,10,15,23,24,27,33,37,44
Lack of awareness of different mental models	15,23,27,31
Inconsistent definitions of AM (QBVM)	19,33,37,41
Current theories emphasize individual	8,37
Inadequate ecological information	6,44
Ideas & methodologies complex	42
Educational	
Lack of knowledge of AM	1,41
Managers lack training in plant ecology	19
Managers lack training in scientific method	19
Scientists lack training in management	19

The Right Information

(Reliability)

Sampling (Survey) Design as a parallel to Experimental Design

Distributing the sample among experimental units	Distributing the sample across space (time)
Experimental	**Sampling (Survey) Design**
Completely Randomized Design	Simple Random Sample
Randomized Complete Block Design	Cluster Design
Factorial Design	Systematic Design
Split-plot Design	Generalized Random–tessellation Stratified Design

The goal should be providing the right information to the right people in the right form at the right time.

The Right Information → Requires Knowledge of the Information Needs

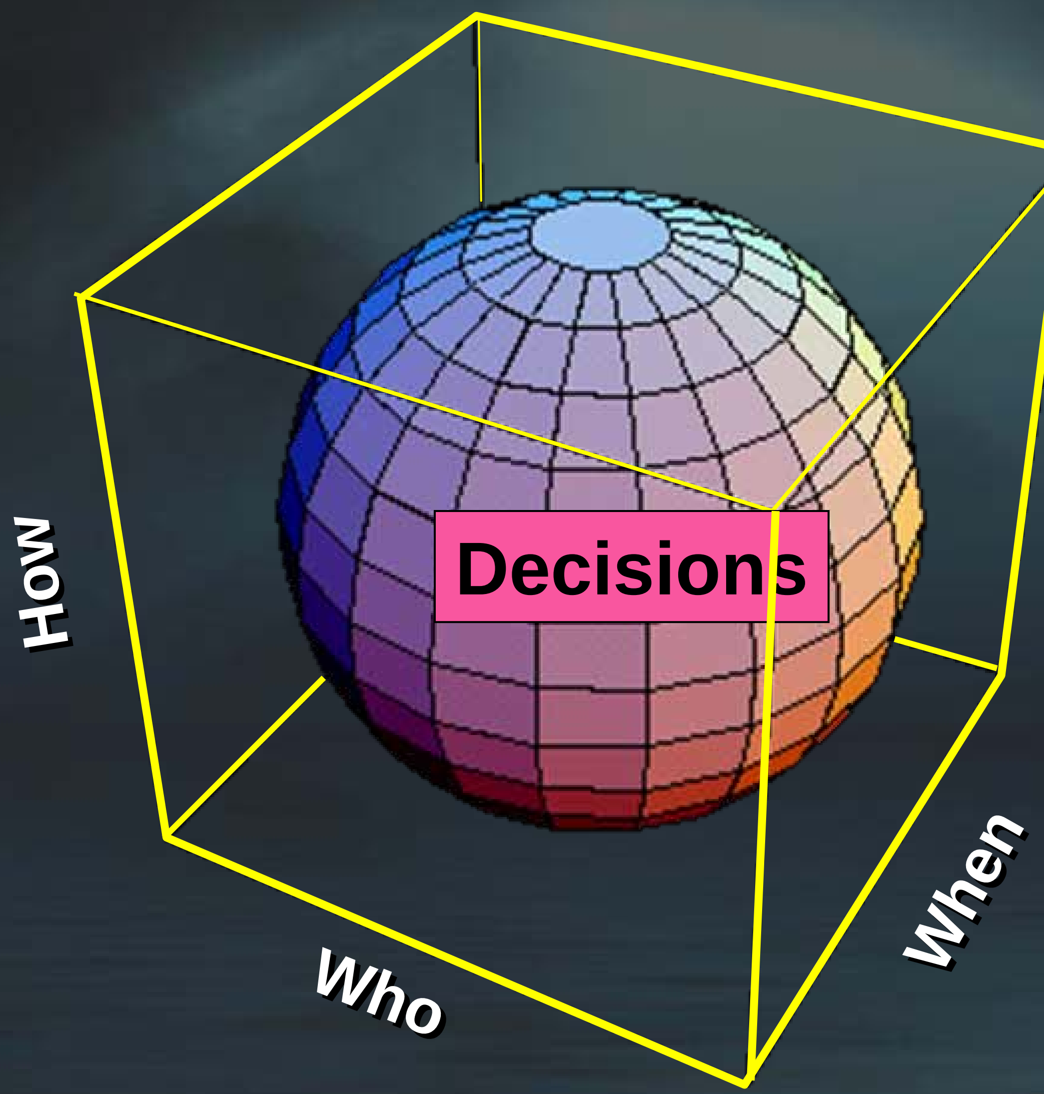
The Right People

The Right Form

The Right Time

} Requires Knowledge of the Decision Process

Decision Space



The Right People

Who makes the decisions?

Who informs the people that make the decisions?

Who gathers the information for the people that inform the people that make the decisions?

Information → Decision Makers

The Right People

The Right Form

Here is a typical Park Superintendent

Scientific Journals

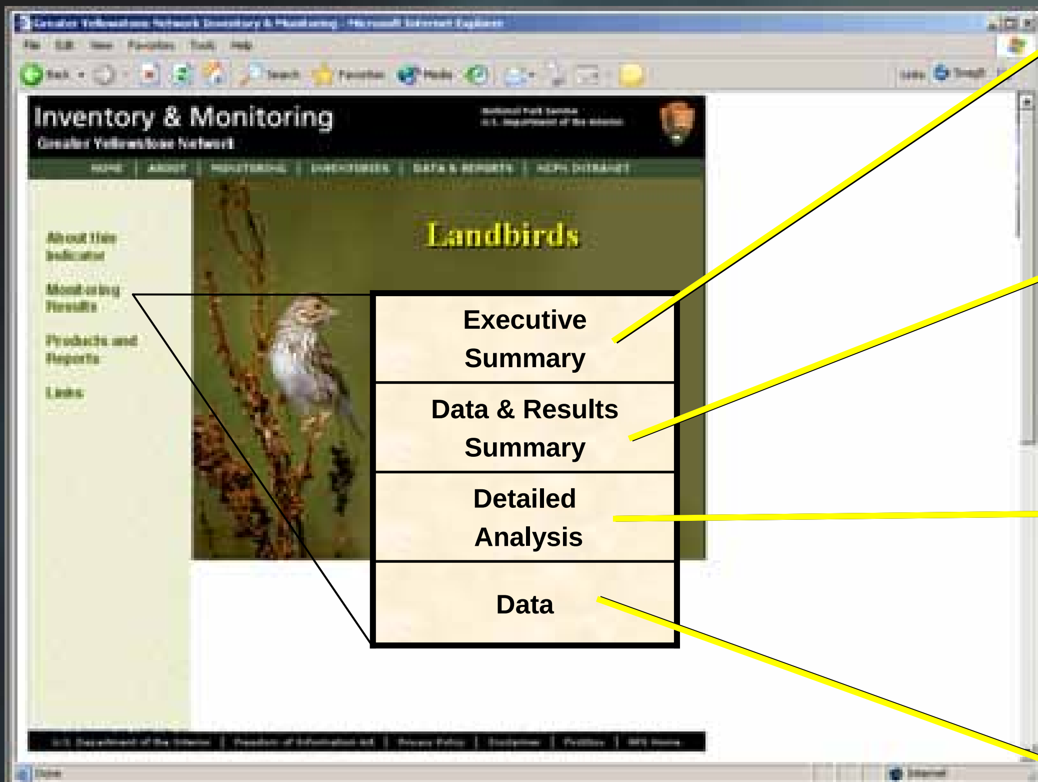
Here is a Park Superintendent that uses the latest issue of "Ecology" to inform management.

Any Questions?

The Right Form

So, does this imply that publishing papers in Ecology is not a good means of communication?

The Right Form



This level would be a very succinct summary intended for high-level managers

This level would be a summary of the data and results targeted for park managers, interpretive staff, and/or public looking for a little more detail.

This level would be a detailed data analysis summary intended for park resource specialists or scientists seeking detailed information.

This level would be the actual data intended for park resource specialists or scientists needing to conduct independent analyses.

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Whitebark Pine

Source GRYN

Last Update 12/04/2005

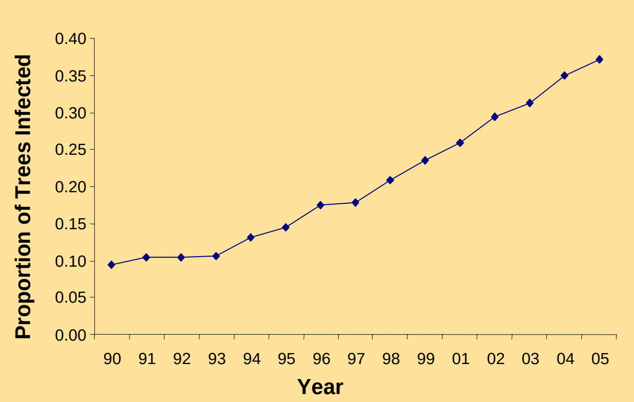
Click for D more detail. or G for graphic.

Importance

Whitebark pine is considered a "keystone" species in the subalpine ecosystem. D Its best known role in these ecosystems is as a high-energy food source for a variety of wildlife species, including grizzly bears. Dramatic declines of whitebark have been reported throughout its range G due to two major factors: 1) an introduced fungus, white pine blister rust; and 2) heavy mortality from endemic mountain pine beetle.

Status

- Thirty six of the 51 (71%) transects had some indication of blister rust. G
- Although blister rust was widespread, the infection severity was relatively low.
- The estimate proportion of trees infected with blister rust within the GYE to be 0.189 ± 0.05 SE, and most infected trees had ≤2 cankers. D G



Discussion

Our preliminary results indicate that the occurrence of white pine blister rust is widespread throughout the GYE, although in most cases, severity is at relatively low levels.

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Whitebark Pine Issues

White pine blister rust

White pine blister rust, an exotic fungus first introduced to North America in Vancouver, British Columbia in 1910, enters the stomata of the whitebark pine needles and then erupts into cankers on the branches, leading to the cessation of cone production and the eventual death of the tree in some cases (Tomback et al. 2001). White pine blister rust also requires Ribes species as an alternate host (Tomback et al. 2001). Depending on the level of infection, a tree with white pine blister rust can live for several years; however, saplings that are infected generally die within three years (Koteen 2002). Infection by blister rust also weakens the tree and tends to lead to death by an accumulation of factors, including mountain pine beetle, other pathogens, root diseases and unfavorable climatic conditions (Koteen 2002).

Mountain Pine Beetle

The mountain pine beetle (Dendroctonus ponderosae) is a native insect that has coevolved with pine forests in the western U.S. (Logan and Powell 2001). Host tree species of mountain pine beetle include: ponderosa pine, lodgepole pine, western white pine and whitebark pine (Kipfmueller and Swetnam 2002). In some species, such as lodgepole pine, mountain pine beetle plays a significant role in its continuation on the landscape through providing periodic disturbances that kill trees and create vast tracks of dead needles that serve as fine fuels for fire ignition and spread (Logan and Powell 2001).

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Whitebark Pine

Source GRYN

Last Update 12/04/2005

Click for D more detail. or G for graphic.

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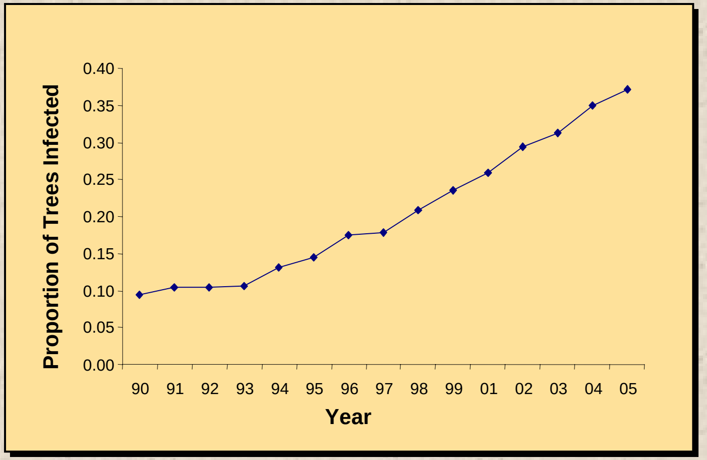
Whitebark pine is considered a “keystone” species in the subalpine ecosystem. D Its best known role in these ecosystems is as a high-energy food source for a variety of wildlife species, including grizzly bears. Dramatic declines of whitebark have been reported throughout its range G due to two major factors: 1) an introduced fungus, white pine blister rust; and 2) heavy mortality from endemic mountain pine beetle.



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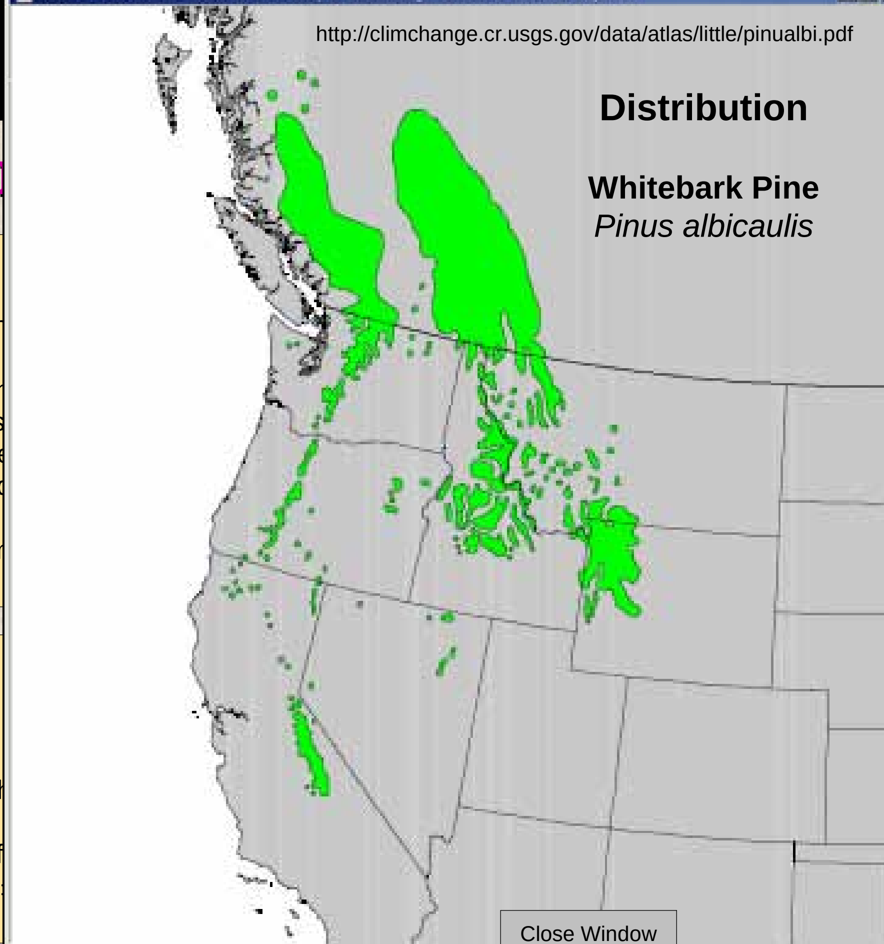

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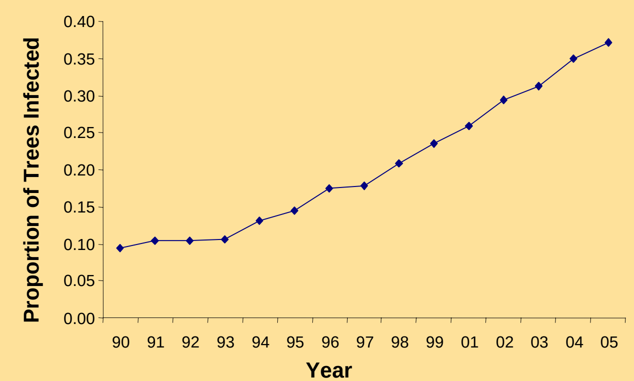

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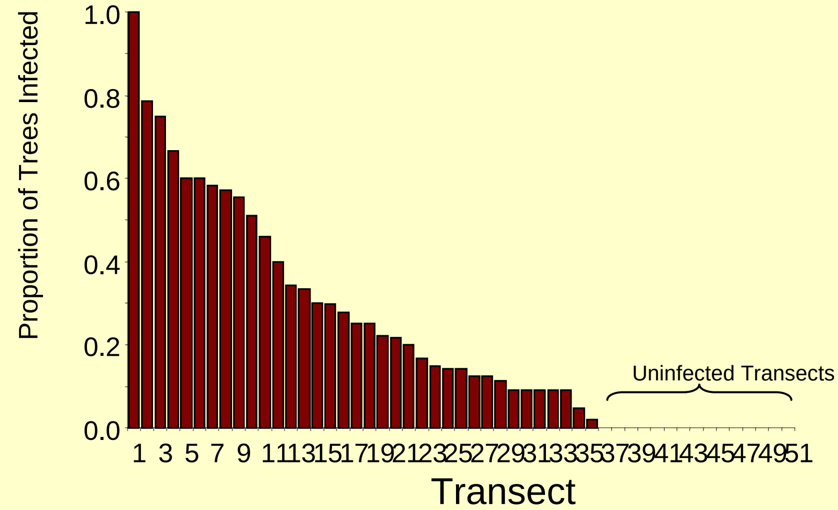

Figure 2. The proportion of whitebark pine trees infected on each of the 51 transects sampled during 2004 arranged in rank order from most infected to least infected.

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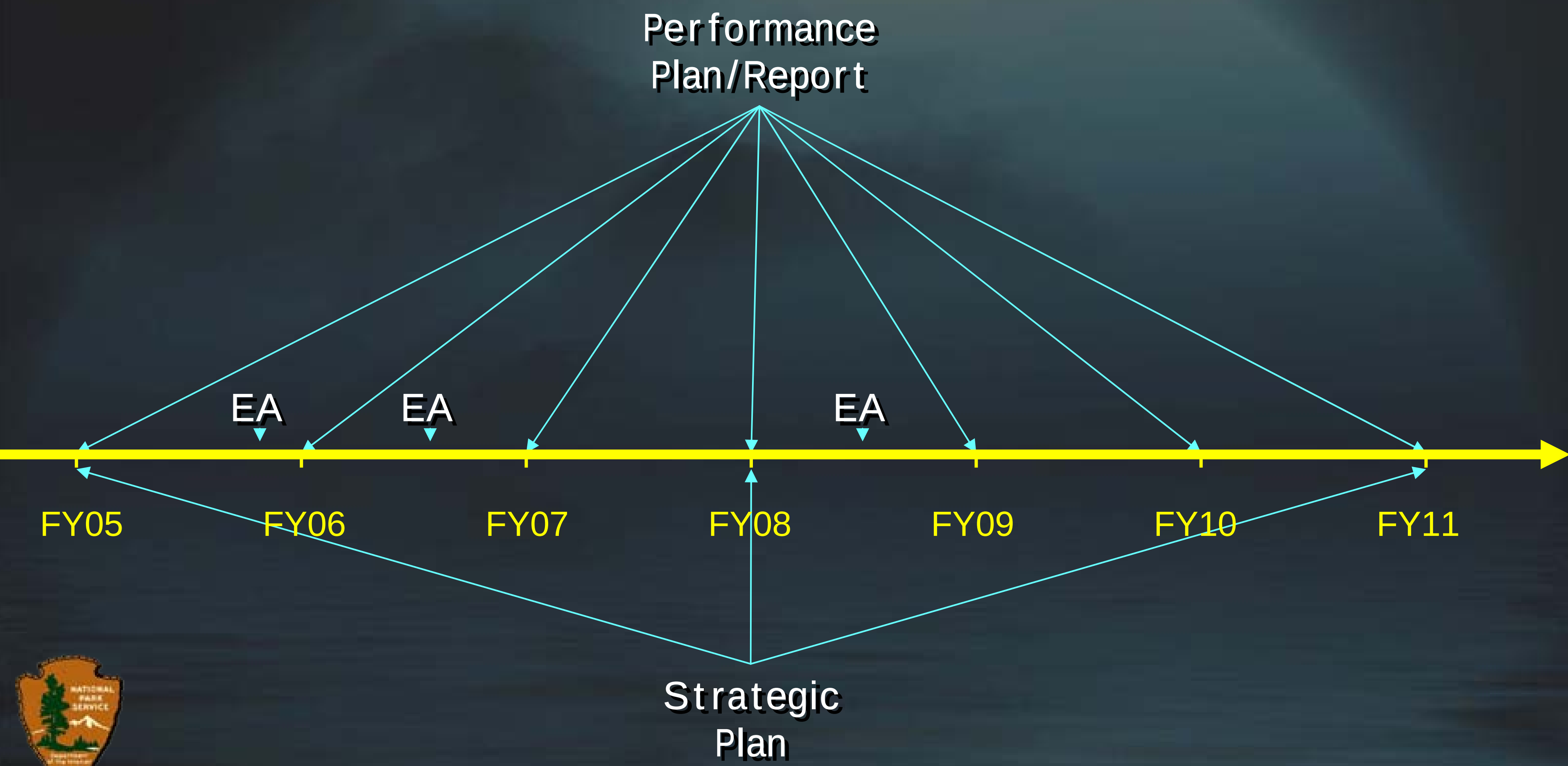
The Right Time



The Right Time